ACTA Acta Sci. Pol., Administratio Locorum 25(3) 2026, 475–490.
https://czasopisma.uwm.edu.pl/index.php/aspal plISSN 1644-0749 eISSN 2450-0771 DOI: 10.31648/aspal.12356

ORIGINAL PAPER
Received: 05.02.2026 Accepted: 26.03.2026

ALLEVIATING OVER-TOURISM AND ADVANCING SUSTAINABLE TOURISM ON CORAL ISLAND THROUGH VIRTUAL REALITY

Sanjoy Kumar Acharjee[1], Shohel Md. Nafi[2]

[1] ORCID: 0009-0002-0270-5293
[2] ORCID: 0000-0003-4131-4105
[1,2] Noakhali Science and Technology University, Department of Tourism and Hospitality Management Sonapur, Noakhali-3814, **Bangladesh**

ABSTRACT

The main objective of this study is to examine how virtual reality (VR) might help reduce overtourism in places with coral islands. A purposive sampling approach was used to reach people who had previously engaged in or were interested in VR tourism because there was no easily accessible database of VR users. A structured questionnaire was designed to collect data. Data were collected from 300 respondents, as 370 questionnaires were distributed among the respondents. Data analysis was conducted using Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS version 4.0. Research involving complex models and non-normal distributions is thought to benefit greatly from the use of PLS-SEM. The study finds that, to combat overtourism and improve sustainability in coral island destinations, this paper examined the potential of VR tourism experiences. The findings, based on frameworks for sustainable tourism, demonstrate that VRTE positively affects several important sustainability outcomes.

Keywords: over-tourism, virtual reality, sustainable tourism, Island

INTRODUCTION

Island tourism is one of the most attractive tourism segments for tourists because of their geographical location and natural settings (Butler & Dodds, 2022). Coral reefs and the marine environment have been dramatically affected by tourism in many destinations. It is commonly known that excessive, uncontrolled tourism can harm coral reefs through pollution, direct visitor exposure, damage to anchors, and sedimentation from overdevelopment and coastal erosion (Diedrich, 2007). Nonetheless, positive changes in coral reef conservation can also be driven by tourists. Thus, Diedrich (2007) mentioned that island-based tourism may increase the quality of life of local people as it creates new earning opportunities besides their traditional job like fishing. The economic benefits of visitor spending have come at the cost of environmental deterioration and ecosystem destruction due to the exponential growth of tourism to coral reef destinations (Hoegh-Guldberg et al., 2007).

Mass tourism has a variety of interrelated effects on coral islands. Between 300,000 and 500,000 tourists visit well-known locations like Koh Tao, Thailand's Turtle Island, each year, causing serious environmental stress on fragile coral ecosystems (UNEP-WCMC & BIOFIN, 2024). Tourists' ecological harm to corals,

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

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coastal vegetation, and dune systems, wildlife disturbance social effects (Sealey et al., 2014), such as reduced facilities and the perception of overcrowding among residents or visitors (Mateos et al., 2020); potential erosion of essential communal values (Dragovich & Bajpai, 2022); degradation of cultural values (Moshi et al., 2019); and long-term economic effects are some of these effects (Great Barrier Reef Foundation, 2024). These combined effects lead to a vicious cycle in which the very things that attract tourists deteriorate, endangering the ecosystem's and the tourism sector's long-term viability (Najeeb et al., 2025). Researchers, environmentalists, and tourism professionals are now looking for creative ways to preserve these delicate ecosystems and continue to be profitable as a result of this environmental crisis (Sutrisno et al., 2023).

One promising solution to the problems of overtourism in coral island destinations is VR technology (Hofman et al., 2022). Particularly for travelers who have previously experienced VR, VR tourism can offer authenticity and satisfaction levels on par with in-person travel (Kim et al., 2024). By offering immersive, educational experiences that can promote environmental awareness and conservation behaviors, this technological intervention promises to lessen the physical visitor pressure on delicate coral ecosystems (Markowitz et al., 2018). VR experiences have been shown to produce significant environmental engagement. It has been demonstrated that engaging with the marine environment promotes environmentally friendly behavior and interactions (Hofman et al., 2022). Accordingly, more VR interactions could encourage people to engage with the ocean and its inhabitants in a more sustainable manner (Sea Going Green, 2024). Additionally, compared to 2D presentations, VR-based tours enable greater telepresence, and because of their perceived enjoyment and increased telepresence, visitors are more likely to intend to utilise VR in the future and to explore the tourism destination in person (Tavakoli & Mura, 2022). This implies that virtual VR can serve as a marketing tool and a conservation tool, encouraging future travel habits that are more environmentally friendly.

As evidence of the viability and market demand for virtual tourism experiences, the COVID-19 pandemic has increased interest in VR tourism applications (Tavakoli & Mura, 2022). Virtual tourism has the potential to revitalize the travel industry and its inhabitants while contributing to the development of a more sustainable economic model, as technology continues to improve people's lives around the world (Sharma et al., 2024). This technological strategy could change coral island tourism from an extractive to a regenerative industry by combining conservation science, tourism studies, and technological innovation (Andziak, 2025).

This study looks at the various ways VR technology can help reduce overtourism and promote eco-friendly travel strategies on coral islands. The study looks into five main areas such as how well VR works to manage overtourism and reduce physical visits; how it affects environmental awareness and sustainable behavior; how it influences well-informed travel decisions; how it can help local businesses financially; and how it can improve visitor satisfaction by setting reasonable expectations. For destination managers, tourism operators, and policymakers seeking to strike a balance between environmental preservation and economic development in fragile coral island ecosystems, this study offers insights by testing five hypotheses that address these dimensions.

LITERATURE REVIEW

Over the time of its history, the tourism sector has demonstrated itself to be a force in perpetual evolution (Gossling et al., 2023), producing significant changes in travel patterns, visitor inflows, and the carrying capacity of tourist sites (Gore et al., 2024). Thus, the worldwide tourism sector has increased the strain on environmentally delicate locations, particularly coral islands. Despite their economic reliance on tourism, these regions are ecologically vulnerable and facing growing threats from excessive tourism. Up to half a million tourists visit places like Thailand's Koh Tao each year, resulting in environmental damage like coral bleaching, marine pollution, and disturbance of local biodiversity, according to UNEP-WCMC and

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

BIOFIN (2024). According to the Great Barrier Reef Foundation (2024), stressors brought on by tourism, such as crowding and reef trampling, endanger the very ecosystems that visitors come to see. By 2050, 90% of coral reefs are expected to be at high or critical risk if current trends continue. Therefore, immediate innovations are required to strike a balance between tourism growth and environmental preservation.

VR has emerged as a promising tool to reduce the strain on physical tourism due to recent advancements in immersive technologies. A completely virtual, three-dimensional world where people and virtual things interact remotely, is one of the most effective technologies in the tourism industry (Suanpang et al., 2022). Without physically traveling, VR allows users to experience lifelike simulations of locations, which may lessen the need for and the urgency of in-person visits (Guttentag, 2010). VR experiences can provide similar levels of satisfaction to in-person visits, especially for tech-savvy travelers, according to research by Kim et al. (2024). This is consistent with previous research by Tussyadiah et al. (2018), who found that VR increases emotional engagement and telepresence, improving user satisfaction while lowering physical crowding at well-known locations. Previous studies suggest that perceived usefulness, attitudes toward technology, and user desire significantly influence the intention to use VR tourism platforms (Teng et al., 2025).

Furthermore, through environmental education, VR has shown great promise in encouraging sustainable behavior. Immersive virtual experiences raise awareness of ecological issues and promote emotional ties to the natural world (Markowitz et al., 2018; Su et al., 2024). Sea Going Green (2024) asserts that VR can successfully replicate underwater environments, promoting environmentally friendly attitudes and actions. According to Suanpang et al. (2022), constructive engagement with these technologies can improve locals' well-being and help meet the Sustainable Development Goals (SDGs) through virtual tools that promote local development and social cohesion. Ahn et al. (2016) support these findings by arguing that virtual exposure to scenarios of environmental degradation can influence behavioral intentions toward sustainability, making VR a useful tool for conservation messaging. VR has the potential to assist travelers in making more responsible and knowledgeable decisions. According to Tavakoli and Mura (2022), VR previews help travelers avoid making snap decisions by reducing uncertainty and bringing expectations into line with reality. This capability is especially beneficial for delicate locations, such as coral islands, where uninformed tourists may worsen environmental harm. Additionally, VR expands tourism beyond geographical boundaries by providing local businesses with economic opportunities through the sale of eco-educational content and virtual experiences (Ying et al., 2021).

There are still significant gaps in spite of these encouraging advancements. There is little empirical research on VR tourism's actual effects on traveler behavior, destination carrying capacity, or long-term ecological benefits; instead, the majority of studies focus on the technology viability or user experience. Additionally, there is not enough data to determine how VR adoption impacts local economies in isolated island environments. In order to fill these gaps, this study empirically investigates how VR can help coral island destinations by lowering overtourism, raising environmental awareness, assisting small businesses, and encouraging responsible travel.

Along with the technological adoption viewpoints, there is a set of behavioral change theories that can contribute to better understanding of the manner in which immersive media can affect the attitudes and behavior of tourists. According to the Theory of Planned Behavior (TPB), attitudes, subjective norms and perceived behavioral control determine the behavioral intentions. Attitudes towards environmental protection can be reinforced with the help of immersive experiences like VR because they produce emotional involvement and perceived responsibility (Su et al., 2024). Destination management organizations are increasingly incorporating virtual tours as a means of destination promotion and immersive digital experiences of a destination to potential visitors (Beták et al., 2023). On the same

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

note, the Value-Belief-Norm (VBN) theory describes the pro-environmental behavior in terms of personal norms activated by environmental awareness and the notion of consequences. Simulations of vulnerable ecosystems can be virtualized, therefore, mobilizing environmental values and enhancing the intention to sustain behavior.

Also, the discussion of digital substitution and travel stimulation is relevant to VR tourism studies. According to some articles, VR can also replace real traveling by quenching the desire to visit places, whereas others believe that previews in the form of immersion can boost the desire to travel (Tavakoli & Mura, 2022; Tussyadiah et al., 2018). This twofold impact is critical to consider when considering VR as an instrument of controlling overtourism.

THEORETICAL FRAMEWORK

This framework is structured around five key dimensions, each corresponding to a research hypothesis and supported by empirical literature.

VR and Environmental Awareness & Sustainable Attitudes (H1)

Behavior change in tourism contexts has long been associated with environmental education. By graphically illustrating the ecological issues of places like coral bleaching or marine plastic pollution, immersive VR experiences can be effective teaching tools (Markowitz et al., 2018). According to Hofman et al. (2022), virtual marine environments greatly improve ecological empathy and encourage sustainable behavior. As a result, VR serves as both an engagement tool and a catalyst for influencing travelers' pro-environmental sentiments.

H1: VR has a significant effect on creating environmental Awareness & Sustainable Attitudes

VR and Economic Benefits for Local Businesses (H2)

VR offers local tourism operators new revenue streams in the post-pandemic digital economy. Global distribution and monetization are possible for eco--educational packages, gamified cultural experiences, and virtual tours (Hacikara et al., 2024). Andziak (2025) claims that by allowing small businesses to be involved in the digital tourism supply chain, VR not only lessens the physical strain on destinations but also decentralizes economic benefits. This promotes the growth of resilient and inclusive tourism economies, particularly in island communities where tourism is a major source of income.

H2: VR has a significant effect on delivering economic benefits for local business.

VR and Informed & Responsible Travel Decision-Making (H3)

Due to deceptive advertising or a lack of pre-trip education, travelers frequently make snap decisions or poorly informed choices. By providing realistic destination previews, VR has the potential to lessen information asymmetry. Higher degrees of telepresence in VR destination marketing considerably increased travelers' intentions to visit, according to Ying et al. (2021). This effect was mediated by affective reactions like entertainment and beauty and cognitive factors like education. Nevertheless, some research indicates that although VR can offer useful information, its impact on real-world behavioral choices might be less pronounced in the absence of clear decision-support cues (Hacikara et al., 2024). This implies that sustainability messaging needs to be more thoroughly incorporated into VR experiences.

H3: VR has a significant effect on taking responsible travel decisions.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

VR and Reduction in Physical Travel & Over-Tourism (H4)

Since the number of visitors frequently surpasses the ecosystem's carrying capacity, overtourism has been identified as a serious threat to ecologically delicate locations like coral islands (UNWTO, 2018). Guttentag (2010) claims that VR provides realistic simulations that can replace actual travel, negating the need for face-to-face visits to delicate areas. According to Kim et al. (2024), visitors who engage with VR content are sufficiently pleased to think about delaying or canceling their actual travel plans, which helps reduce crowding during busy times. VR can therefore change the flow of tourists and ease the strain on particular regions, supporting calls for more environmentally friendly destination management techniques.

H4: VR has a significant effect on the reduction in physical travel and over-tourism.

VR and Tourist Satisfaction via Realistic Pre-Trip Expectations (H5)

A key component of visitor satisfaction and post-visit assessment is controlling expectations. By offering lifelike sensory simulations, VR can help close the gap between perceived and real experiences (Guttentag, 2010). According to Sharma et al. (2024), tourists who watched VR-based promotional materials expressed greater satisfaction and less post-trip disappointment. VR helps with more precise planning and a better match between promotional content and on-site realities by providing transparency and closing expectation gaps.

H5: VR has a significant effect on tourist satisfaction and providing realistic pre-trip expectations.

METHODOLOGY

The objective of this study was to examine how VR might help reduce overtourism in places with coral islands. A purposive sampling approach was used to reach people who had previously engaged in or were interested in VR tourism because there was no easily accessible database of VR users. This approach is suitable when the target population is small or specialized (Acharya et al., 2013). Using methods from related digital tourism studies, a structured questionnaire was created and disseminated via online channels such as social media, VR forums, and marine environmental organizations (Tussyadiah et al., 2018). Three hundred valid responses were obtained from the 370 survey forms that were distributed. This resulted in an 81.1% response rate, above the PLS-SEM analysis minimum threshold (Hair et al., 2014). Kline (2005) states that for structural path modeling in exploratory research, a sample size of at least 200 is sufficient.

In this study, the respondents were asked to consider the experience of VR tourism at an abstract level, not to use one standardized VR application. As a result, the questionnaire was able to include perceptions and expectations about immersive tourism technologies, as opposed to getting direct responses to a specific VR system. The VR setting offered to the participants included the most common types of immersive tourism, such as 360-degree destination videos, head-mounted display (HMD) experiences, and interactive virtual tour experiences accessible online on tourism websites. These forms usually involve visual immersion, spatial audio and interactive navigation that simulates environments in the real world. Although such a methodological approach allows evaluating the overall attitude to VR tourism adoption, it also has a drawback: the immersion rates, the structure of the experience, and the duration of exposure are not equal across VR platforms, thus may potentially influence the comparability of responses.

VR Tourism Experience (VRTE), Environmental Awareness and Sustainable Attitude (EASA), Informed and Responsible Travel Decision-Making (IRTD), Economic Benefits for Local Businesses (EBLB), Reduction in Physical Travel and Over-Tourism (RPTO), and Tourist Satisfaction via Realistic Pre-trip Expectations (TSRP) were the six latent constructs that were measured by the 35 items in the questionnaire. These constructs were modified

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

from previously approved tools for immersive and digital tourism research (Han et al., 2013). A five-point Likert scale, which is frequently used in behavioral tourism research, was used to measure each item. The range was 1 for "strongly disagree" and 5 for "strongly agree" (Deb & Nafi, 2022). To guarantee instrument clarity and dependability, A pilot test was conducted prior to full implementation. Following the steps suggested by Lee and Jan (2019), a small group of respondents evaluated the survey and made minor changes in response to their comments.

Data analysis was conducted using Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS version 4.0. Research involving complex models and non-normal distributions is thought to benefit greatly from the use of PLS-SEM (Wold et al., 2001). Because of its versatility in examining latent variables and forecasting causal relationships, it has been extensively used in research on digital tourism and innovation (Chatterjee & Kar, 2020). Fig. 1 displays the conceptual framework.

Measures

The measurement scales used in this study were validated by the previously mentioned studies. Several earlier related studies of digital marketing applications served as the foundation for the development of this study's questionnaire. A five-point Likert scale, ranging from "strongly disagree" to "strongly agree," was used to score each construct's items. Table 1 lists every item that was used to collect data.

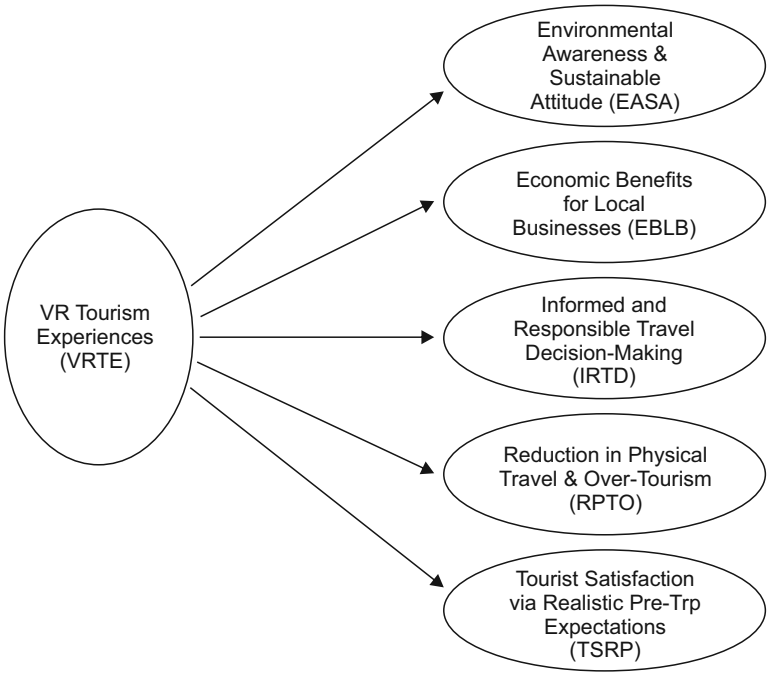


Fig. 1. Conceptual Framework
Source: Author own elaboration.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

Table 1. Items used in the study

Items	References
Factor 1: VR Tourism Experiences	
The VR experience of the coral island felt realistic.	Han et al. (2013)
I was fully engaged while exploring the coral island through VR.	Lo & Cheng (2020)
VR helped me understand the coral island without being there physically.	Tussyadiah et al. (2018)
I see VR as a practical alternative to visiting fragile destinations.	Lo & Cheng (2020)
I would recommend VR tourism for exploring natural sites.	
Factor 2: Environmental Awareness & Sustainable Attitude (EASA)	
VR experiences effectively highlight the environmental challenges faced by Coral Island.	
VR tourism makes me more conscious of the ecological impact of my travel choices.	Jiang et al. (2025)
After experiencing VR tourism, I am more likely to support sustainable travel practices.	Tussyadiah et al. (2018)
VR tourism can serve as an educational tool for promoting environmental conservation.	Lo & Cheng (2020)
Virtual tourism can inspire travelers to respect and protect the environment when visiting physically.	Han et al. (2013)
Factor 3: Economic Benefits for Local Businesses (EBLB)	
Local businesses can benefit financially from VR-based tourism experiences.	Wiangkham et al. (2025)
VR tourism can help promote lesser-known local attractions and businesses.	de Lurdes Calisto & Sarkar (2024)
I am more likely to purchase virtual travel experiences if they support local businesses.	Lo & Cheng (2020)
VR-based tourism can create new economic opportunities for local tourism operators.	Markowitz et al. (2018)
If local businesses offered VR experiences, I would be interested in exploring them before deciding on my trip.	
Factor 4: Informed and Responsible Travel Decision-Making (IRTD)	
VR previews help me assess whether a destination matches my travel expectations.	
After experiencing a VR preview, I feel more confident about my travel plans.	Han et al. (2013)
VR tourism reduces the likelihood of my making impulsive travel decisions.	Hofman et al. (2022)
VR previews help me evaluate a destination's sustainability before visiting.	Jiang et al. (2025)
VR experiences allow me to make better travel choices based on environmental concerns.	
Factor 5: Reduction in Physical Travel & Over-Tourism (RPTO)	
VR experiences provide a satisfactory alternative to physical visits to Coral Island.	
After experiencing VR, I feel less urgency to visit the coral island physically.	Hofman et al. (2022)
VR tourism can help distribute visitors more evenly across different seasons.	Markowitz et al. (2018)
VR tourism can reduce overcrowding in coral islands.	Lo & Cheng (2020)
If VR tourism were more accessible, I would consider postponing or avoiding travel to Coral Island.	Han et al. (2013)
Factor 6: Tourist Satisfaction via Realistic Pre-Trip Expectations (TSRP)	
VR tourism marketing provides a realistic representation of a destination.	Sharma et al. (2024)
After experiencing VR marketing, I feel more informed about what to expect from my trip.	Ying et al. (2021)
VR previews can reduce the chances of disappointment after visiting a destination.	Guttentag (2010)
I would trust a destination more if its marketing materials included VR previews.	
VR-based tourism marketing helps travelers plan their trips more effectively.	

Source: Author own elaboration.

RESULTS AND DISCUSSION

PLS-SEM is used in this study to test the hypothesis and suggested model. PLS-SEM is widely used in marketing (Hair et al., 2014), tourism management, and strategic management (Hair et al., 2021). PLS-SEM is a powerful method that can handle datasets with non-normal distributions and predict complex models without requiring distribution assumptions (Hair et al., 2014). Due to these advantages, PLS is used in this study to assess relationships.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

Socio-demographic analysis

Table 2 displays the respondents' demographic profiles. Of the sample, 55.3% (166 respondents) were male and 44.7% (134 respondents) were female. 9,0% (27 respondents) of the respondents were between the ages of 31 and 40, while a sizable portion (78.7%) were between the ages of 20 and 30 (236 respondents). Approximately 6.0% (18 respondents) were under 20, and 5.0% (15 respondents) were between the ages of 41 and 50. 4 responders, or just 1.3%, were older than 50. Regarding educational background, 23.7% of respondents (71 respondents) had a graduate degree or above, while the majority of respondents (67.7%) had finished their undergraduate degree (203 respondents). Just 26 respondents, or 8.7%, had completed high school or less. 27% (82 respondents) said they were very familiar with VR tourism, 45% percent (136 respondents) said they were moderately familiar, and 21% (64 respondents) said they were somewhat familiar. Just 18 people, or 6.0% of the respondents, said they had no knowledge of VR tourism.

Table 2. Respondent's socio-demographic profile

Variable		Frequency	Percentage
Gender	Male	166	55.3
	Female	134	44.7
Age	0–20	18	6.0
	20–30	236	78.7
	31–40	27	9.0
	41–50	15	5.0
	50 above	4	1.3
Educational qualification	High school or below	26	8.7
	Undergraduate	203	67.7
	Graduate or higher	71	23.7
Familiarity with VR tourism	Highly familiar	82	27.3
	Moderately familiar	136	45.3
	Somewhat familiar	64	21.3
	Not familiar	18	6.0

Source: Author own elaboration.

Measurement Model

In accordance with Bollen and Noble's (2011) recommendations, the measurement model was evaluated by analyzing the connections between latent constructs and their observed indicators using CFA (Confirmatory Factor Analysis). Convergent and discriminant validity for the study's constructs were the main goals of the evaluation. Cronbach's alpha (CA), average variance extracted (AVE), composite reliability (CR), reliability coefficient (rho_A), and factor loadings were the five main metrics used to evaluate convergent validity. The outcomes of factor loadings, CA, rho_A, CR, and AVE are shown in Table 3. As suggested by Hulland et al. (1996) indicators with standardized factor loadings below 0.70 were not included in the analysis. Consequently, factor loadings below the acceptable threshold of 0.70 led to the removal of VRTE1, EBLB1, and IRTD4 from the model. Following their removal, the updated model maintained strong factor loadings for every other item, all of which were greater than 0.70, suggesting convergent validity and acceptable item reliability.

All values of AVE are greater than 0.50, and the values of CA, rho_A, and CR for every construct surpass the minimal cutoff of 0.70. These findings support the model's sufficient convergent validity (Fornell & Larcker, 1981). The outcome demonstrates that every value satisfies the CA, rho_A, CR, and AVE recommendations. Fig. 2 displays the study's measurement model.

Common method bias was assessed using the full collinearity approach based on variance inflation factors (VIF), as recommended by Kock (2015). In this approach, VIF values below the threshold of 5 indicate that common method bias is not a serious concern. As shown in Table 4, all VIF values are within the acceptable range, suggesting that common method bias is unlikely to affect the results of this study. The Fornell-Larcker criterion, which states that the AVE's square root for each construct must be

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

Table 3. Item loadings, reliability, and validity

Variables	Items	Loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
VR Tourism Experiences (VRTE)	VRTE2	0.808	0.837	0.853	0.884	0.605
	VRTE3	0.798				
	VRTE4	0.766				
	VRTE5	0.802				
Reduction in Physical Travel & Over-Tourism (RPTO)	RPTO1	0.784	0.818	0.824	0.879	0.646
	RPTO2	0.797				
	RPTO3	0.776				
	RPTO4	0.803				
	RPTO5	0.827				
Environmental Awareness & Sustainable Attitude (EASA)	EASA1	0.731	0.768	0.769	0.852	0.589
	EASA2	0.780				
	EASA3	0.764				
	EASA4	0.850				
	EASA5	0.761				
Informed and Responsible Travel Decision-Making (IRTD)	IRTD1	0.751	0.857	0.862	0.897	0.636
	IRTD2	0.789				
	IRTD3	0.777				
	IRTD5	0.753				
Economic Benefits for Local Businesses (EBLB)	EBLB2	0.806	0.856	0.858	0.897	0.635
	EBLB3	0.826				
	EBLB4	0.822				
	EBLB5	0.759				
Tourist Satisfaction via Realistic Pre-Trip Expectations (TSRP)	TSRP1	0.785	0.804	0.804	0.872	0.630
	TSRP2	0.793				
	TSRP3	0.816				
	TSRP4	0.794				
	TSRP5	0.797				

Source: Author own elaboration.

Table 4. Collinearity Statistics

Construct	VIF
VRTE	2.54
EBLB	3.31
IRTD	2.91
RPTO	2.41
TSRP	1.76

Source: Author own elaboration.

higher than the correlation coefficients between all other constructs and that one, was used to evaluate discriminant validity (Fornell & Larcker, 1981). This ensures that, compared to other constructs in the model, the construct shares a higher amount of variance with its indicators. The square root of the AVE for each construct exceeds its correlations with all other constructs in every instance, indicating satisfactory discriminant validity. Notably, despite the high correlation (0.953) between VRTE and EBLB, each variable's square root of AVE is still higher, meeting the Fornell-Larcker criterion. However, this may call for additional consideration during the structural model phase in order to assess any potential multicollinearity or conceptual overlap. Although the relationship between VRTE and EBLB is very high, as indicated by a correlation coefficient of 0.953, discriminant validity using HTMT and multicollinearity using VIF were found to be within acceptable limits, suggesting that these constructs have empirical discriminant validity (Hair et al., 2021; Henseler et al., 2015). The high relationship is theoretically expected, as virtual tourism experiences have a significant influence on tourists' behavioral intentions and expected expenditure, thereby impacting perceptions of economic benefits (Beck et al., 2019; Tussyadiah et al., 2018). Furthermore,

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

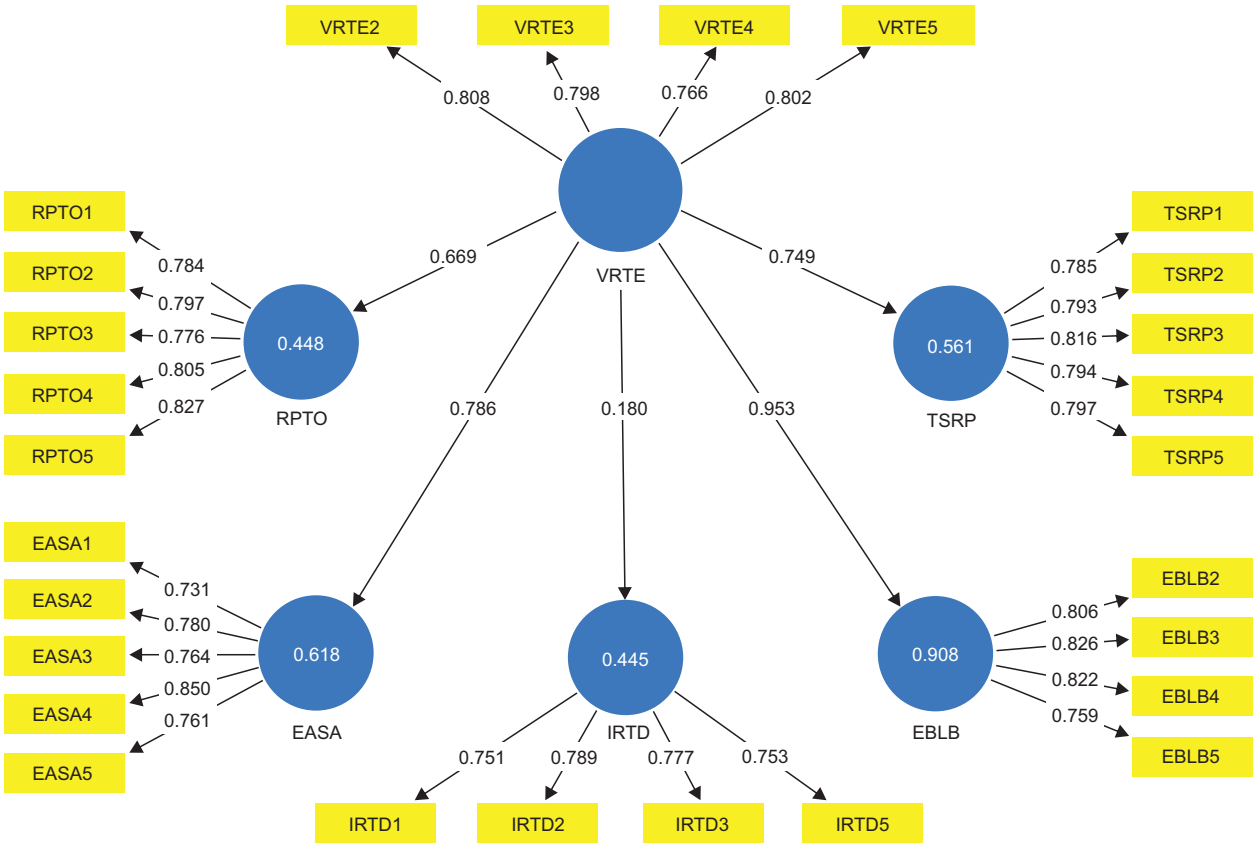


Fig. 2. Measurement model
Source: Author own elaboration.

these constructs share a common base as they are both perception-based, and such consistency could enhance the relationship due to cognitive consistency (Podsakoff et al., 2003). Table 5 indicates satisfactory discriminant validity since the square root of AVE is higher than the values of correlation. In addition to the Fornell-Larcker criterion, discriminant validity was also assessed using the Heterotrait–Monotrait ratio (HTMT) shown in table 6. All HTMT values were below the recommended threshold of 0.90, indicating that the constructs are empirically distinct and that multicollinearity among latent variables is not problematic.

Table 5. Interconstruct reliability and correlations

Variables	EASA	EBLB	IRTD	RPTO	TSRP	VRTE
EASA	0.778					
EBLB	0.684	0.804				
IRTD	0.691	0.629	0.768			
RPTO	0.740	0.636	0.621	0.798		
TSRP	0.734	0.734	0.615	0.643	0.797	
VRTE	0.786	0.953	0.667	0.669	0.749	0.794

Note: The square root of the constructs' AVE is represented in italic
Source: Author own elaboration.

Table 6. Heterotrait-Monotrait Ratio (HTMT)

Constructs	VRTE	EBLB	IRTD	RPTO	TSRP
VRTE	—				
EBLB	0.871	—			
IRTD	0.644	0.707	—		
RPTO	0.618	0.675	0.721	—	
TSRP	0.584	0.633	0.696	0.744	—

Source: Author own elaboration.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

Structural Model

Standardized path analysis was utilized to examine the proposed relationships among the constructs. The purpose of the structural model analysis was to investigate the direct effects as well as general patterns of relationships among the variables in the conceptual framework. The model sought to test the significance and strength of the suggested paths as well as to find tenable cause-and-effect relationships. Examining the effects of the VR Tourism Experience (VRTE) on different outcome variables was made possible by this analytical method. Fig. 3 depicts the current study's structural model. To assess the explanatory power of the model, the R^2 values were used, which determine the percentage of variance that the independent variables explain. The model had a moderate explanatory power among the endogenous constructs (table 7). The Stone, Geisser Q^2 test was used to evaluate predictive relevance in table 7, and the Q^2 values were all positive, thus indicating that the model has enough predictive relevance.

Table 7. R and Q Square Result

Construct	R^2	Q^2
EASA	0.472	0.331
EBLB	0.580	0.421
IRTD	0.465	0.334
RPTO	0.399	0.272
TSRP	0.510	0.361

Source: Author own elaboration.

Table 8 illustrates the results of the path coefficient. All five of the hypotheses tested in this study had positive coefficients and were deemed statistically

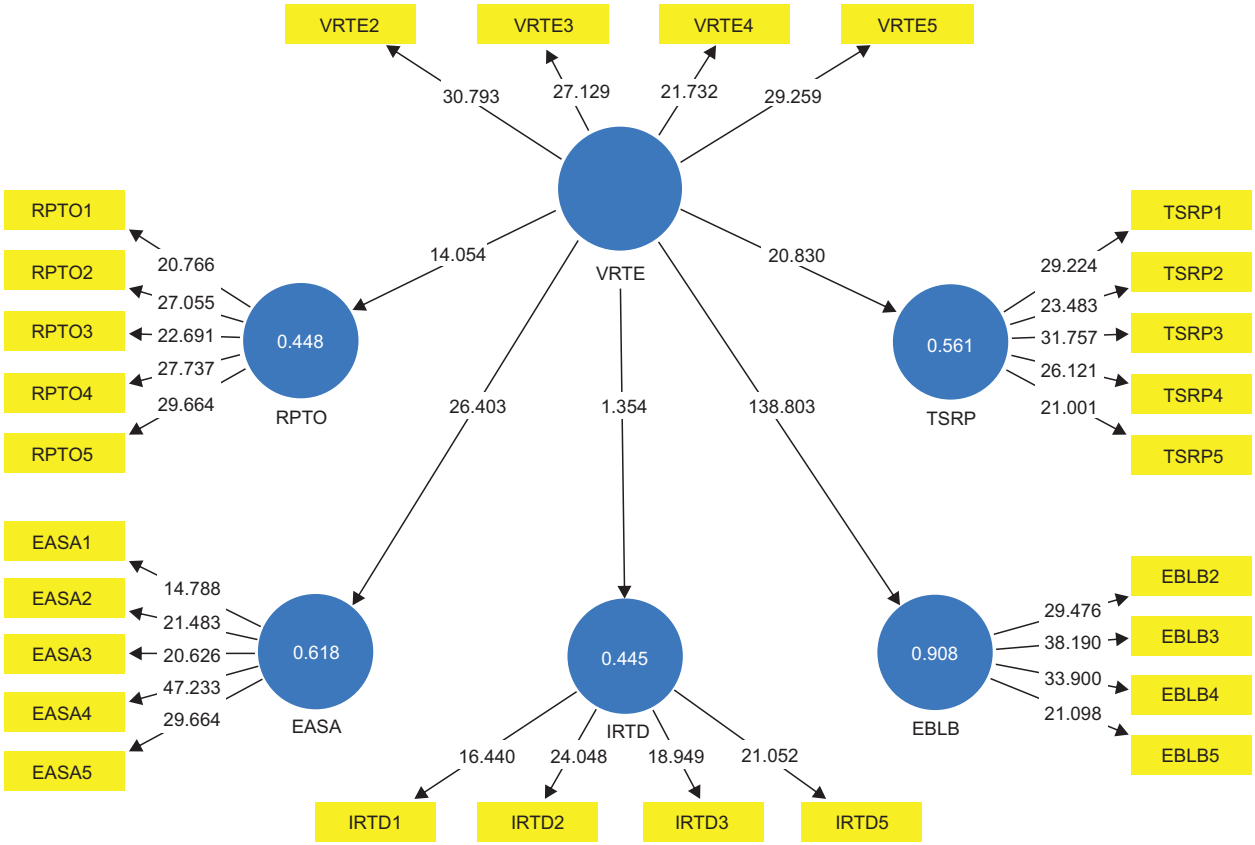


Fig. 3. Structural model
Source: Author own elaboration.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

Table 8. Hypothesized Structural Model Results

Hypothesis	Path	Path coefficient	T statistics	f^2	P values
H1 (supported)	VRTE -> EASA	0.786	26.403	0.283	0.000
H2 (supported)	VRTE -> EBLB	0.953	138.803	0.451	0.000
H3 (Not supported)	VRTE -> IRTD	0.180	1.354	0.211	0.178
H4 (supported)	VRTE -> RPTO	0.669	14.054	0.180	0.000
H5 (supported)	VRTE -> TSRP	0.749	20.830	0.255	0.000

Source. Author own elaboration.

significant. With a path coefficient of β = 0.786 and a p-value ≤ 0.000, the result shows that VRTE has a strong positive influence on Environmental Awareness & Sustainable Attitudes (EASA), supporting H1.

H2 is also supported by the highly significant effect of VRTE on Economic Benefits for Local Businesses (EBLB) (β = 0.953, p ≤ 0.000). However, a low path coefficient (β = 0.180), T-statistic (1.354), and p-value of 0.178 indicate that VRTE has no discernible effect on Increasing Responsible Tourist Decision-making (IRTD). H3 is therefore not supported. The results show that VR experiences have the potential to increase awareness and create expectations, but not necessarily responsible decision-making. Behavior change will demand more education, value activation and the contextual cues. Guided interpretation, sustainability messaging and interactive learning should therefore be integrated in platforms of VR

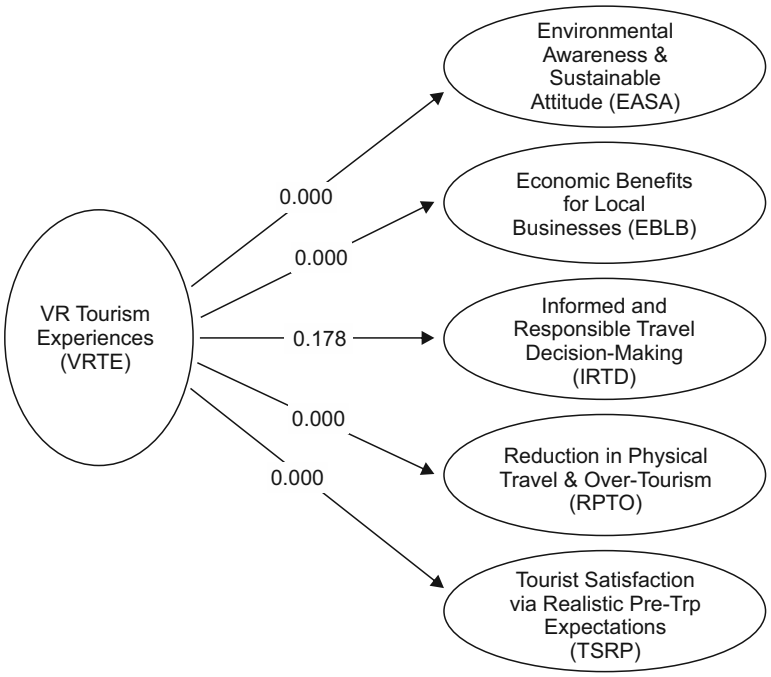


Fig. 4. Structural model with path coefficient
Source: Author own elaboration.

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

tourism in order to influence responsible travel choices. The effect size (f^2) was checked in order to measure the contribution of each exogenous construct to the endogenous variables (table 8). The results showed that the impact of VRTE is large for EBLB, while the impact of VRTE is moderate for EASA, IRTD, and TSRP, and small to moderate for RPTO.

Additionally, with a path coefficient of $\beta = 0.669$ and $p \leq 0.000$, the results show that VRTE positively contributes to reduction in physical travel and over-tourism (RPTO), supporting H4. Lastly, with a path coefficient of $\beta = 0.749$ and a statistically significant p-value ≤ 0.000, VRTE shows a strong positive effect on tourist satisfaction via realistic pre-trip expectations (TSRP), supporting H5.

Four of the five proposed relationships are thus confirmed to be statistically significant by the structural model analysis. Because of its low significance, H3 (VRTE → IRTD) was not supported. The structural model with the path coefficient for this investigation is displayed in Fig. 4. These findings support the suggested conceptual framework and imply that VRTE has a major impact on outcomes linked to responsible and sustainable tourism.

CONCLUSION

In order to combat overtourism and improve sustainability on coral island destinations, this paper looked at the potential of VR tourism experiences, or VRTE. The findings, based on frameworks for sustainable tourism, suggest that VRTE is perceived as positively influencing several important sustainability outcomes. Through realistic pre-trip experiences, VR is perceived by respondents as helping align tourist expectations, enhancing economic benefits for local businesses, reducing the perceived urgency of physical travel, and increasing environmental awareness. According to these results, VR appears to have the potential to influence travel habits by offering entertaining and instructive alternatives to in-person travel, particularly in environmentally sensitive regions. The findings further support the perceived efficacy of VR as a marketing and conservation tool in destination management, with strong support for the majority of the hypotheses put forth.

This study finds that VRTE had no visible impact on making responsible and informed decisions. This emphasizes the need for VR content that actively promotes moral and sustainable travel practices through context-driven narratives and embedded guidance, while also providing entertainment and information. VR is perceived to have considerable potential as a tool to promote eco-friendly travel. VR may contribute to the transition of tourism, from a historically extractive model to one that is more regenerative and balanced by offering immersive, accessible, and ecologically responsible alternatives. These observations may have important implications for legislators, VR content creators, and tour operators who want to preserve the economic viability of island tourism while preserving delicate marine ecosystems.

Theoretical Implications

This study supports immersive experiences and their application to digital tourism by demonstrating that VR Tourism Experiences can impact important sustainability outcomes. The benefits on reducing physical travel, raising environmental awareness, and boosting local economies show how VR can influence attitudes and perceptions. To influence sustainable behaviors, VR design must include cognitive and decision-support components, as the non-significant impact on informed decision-making indicates that emotional immersion alone may not be enough.

Practical Implications

This study results provide useful direction for policymakers, developers, and planners in the tourism industry. In order to increase awareness and lessen the environmental impact on coral island destinations, VR can be utilized as an effective teaching and marketing tool. By enabling local communities to produce and market virtual experiences, it also offers business opportunities and promotes economic resilience. Clear prompts and sustainability-focused cues should be

✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

integrated into VR content to enhance its effectiveness and guide travelers toward more responsible and informed travel decisions.

Limitations and Future Scope of Study

Although this paper makes significant contributions to the fields of VR and sustainable tourism, some of its limitations present chances for additional research. People who had previously been exposed to VR made up the majority of the research sample, which might not accurately reflect the general travel population. Furthermore, rather than monitoring actual behavioral outcomes or long-term environmental effects, the study concentrated on the behavioral intentions of the participants. The majority of the respondents were between 20 and 30 and this could be due to the fact that younger individuals are more acquainted with digital technologies. Further studies are needed to sample a larger population to enhance the overall validity of the findings among different classes of tourists.

By using longitudinal designs to investigate whether enhanced environmental awareness from VR results in long-lasting behavior change, future research could build on these findings. Experimental research may also be able to determine which particular aspects of VR content – like narrative style, interactivity, or integrated decision-support cues – have the greatest impact on consumers' decisions to travel responsibly. Future research could also look into how VR tourism affects local economies, especially in underrepresented areas, and how hybrid tourism models that blend virtual and real-world experiences can improve sustainability and financial sustainability.

Ethical considerations

The study followed standard ethical guidelines for social science research. Participation in the survey was voluntary and anonymous, and respondents were informed about the academic purpose of the study before completing the questionnaire. Informed consent was obtained from all participants, and no personally identifiable information was collected.

Data availability statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

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✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd

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✉acharjee.thm@nstu.edu.bd, ✉smnafi.thm@nstu.edu.bd